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BAYLOR UNIVERSITY BULLETIN
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CHEMISTRY IN HIGH SCHOOLS

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Baylor University Bulletin

PUBLISHED QUARTERLY AT WACO, TEXAS, BY

BAYLOR UNIVERSITY

AND EDITED BY THE FACULTY

HENRY LEE HARGROVE, PH. D.,
EDITOR-IN-CHIEF

EDITORIAL COMMENT

We present in this number a valuable article on Chemistry by Dr. E. Emmet Reid.

Baylor Summer School begins June 8 and ends July 27 with the state examination for certificates.

The next number of THE BULLETIN will be the annual catalogue. The October number is devoted to President Brooks' Annual Statement.

From present indications the Summer School will be larger than ever before and, we trust, better. Those wanting the Announcement will please address the Dean. Correspondence is solicited.

The first intention was to devote this number to the general subject of Science, but for want of space it was at the last moment decided to treat only Chemistry and leave Biology and Physics for future issues.

BAYLOR SUMMER SCHOOL

June 8 to July 27

SPECIAL FEATURES

There are several features to which the attention is directed:

1. Public Lectures.—A series of lectures on topics of general interest will be given by some of the best known scholars and speakers of the state and the South.

2. Round Table Conferences.—Of special interest to public teachers will be these free and easy discussions on subjects of vital interest.

3. Lessons in Music.—A rare opportunity is afforded those who wish to cultivate this fine art. Regular college professors will be in residence and as their time will not be taxed they can give more careful direction to their students.

4. Kindergarten Methods.—We count ourselves fortunate in being able to secure a specialist to conduct a Kindergarten Observation Class for two weeks, which will be free to all.

5. Bible School.—For the first two weeks the Bible School will be in session and the days and nights will be crowded with good things. There will be many specialists of national repute.

6. Physical Culture.—Mrs. J. W. Erps, Physical Director for young ladies in Baylor, a competent teacher of the Swedish and German methods, will give special training to those desiring such.

COLLEGE CREDITS

It is a ruling of the University that no student shall be allowed to take more than two full courses (6 credits) during the summer. This will be enforced. In special cases a student may take two review subjects to remove conditions and one new course.

ADVICE TO TEACHERS

Teachers are advised to concentrate wisely on a few subjects. There is danger in trying to take everything. Leave off the easy ones and take the few which are most likely to prove difficult. It is absurd for a teacher to try to review during eight weeks the seventeen studies required for a first grade certificate.

EXPENSES

Incidental fee to be paid by all	$ .50
Academy Studies each	5.00
College Studies each	6.00
Teachers' Normal course	10.00

Charges for piano, voice, physical culture, etc., may be learned by writing to the teacher of these respective departments.

Hon. R. B. Cousins, State Superintendent of Public Instruction, has authorized the Baylor Summer Normal to submit the state examination to those attending and desiring the various teachers' certificates. The Baylor Faculty has again agreed to pay the examination fee of $1.00 for each applicant. The further advantages of a Normal in connection with a University are seen in the superb equipment, the free use of a library of 15,000 volumes, the opportunity to take college studies, the gain in cultural effects which result from work done with professors trained in the best universities in the world.

FACULTY FOR 1905

SAMUEL PALMER BROOKS, LL. D., ... *President*

A. B. (Yale, 1894); A. M. (ib., 1902); LL. D. (Richmond College, 1903).

HENRY LEE HARGROVE, Ph. D., Dean, ... *English*

A. M. (University of Nashville, 1892); Ph. D. (Yale, 1902); Author of King Alfred's Old English Version of St. Augustine's Soliloquies, and Translation of Same into Modern English.

WADE HILL POOL, A. B., Secretary, ... *Latin*

A. B. (Baylor, 1887); Harvard Summer School, 1903; Dean of the Academy.

JESSE BRELAND JOHNSON, Ph. D., ... *Mathematics*

A. B. (Baylor, 1893); Ph. D. (Yale, 1895).

ROBERT GREEN HALL, A. M., ... *History*

A. M. University of Alabama, 1893); Principal of Cleburne High School.

WILLIAM B. BIZZELL, B. S., ... *Methods*

B. S. (Baylor, 1898); Superintendent of Navasota Schools.

KATE GRIFFITH, Ph. B., ... *German and French*

Ph. B. (University of Chicago, 1901); Graduate Student, (Berlin, 1901-3).

CHARLES B. COLE, ... *Pedagogy*

Principal of Third Street School, Waco.

OLLIE BELLE BARRON, A. B., ... *Greek*

A. B. (Baylor, 1904); Burleson Fellow in English.

J. FRANK MCDONALD, ... *Science*

Assistant in Chemistry, Senior Class of Baylor, 1905.

MYRA M. WINCHESTER, ... *Kindergarten*

Associate Principal of Fort Worth Kindergarten College; Graduate of Chicago Kindergarten College.

RUDOLF HOFFMANN, ... *Pianoforte, Pipe Organ, Theory*

Royal Conservatory of Music, Leipsic; Director of Music in Baylor.

ALBERT EDOUARD WELLS, ... *Pianoforte*

EDWIN A. SCHAFFER, ... *Pianoforte*

HARRY JOHNSON SPANELL, ... *Voice*

MRS. HENRY LEE HARGROVE, ... *Voice*

MRS. J. W. ERPS, ... *Physical Culture*

JOHN E. SURRATT, ... *Librarian*

JOHN K. STRECKER, ... *Curator of Museum*

CHEMISTRY IN THE HIGH SCHOOL

E. EMMET REID, Ph. D.

A CENSUS OF CHEMISTRY IN TEXAS

My endeavor has been to take a sort of census of the instruction in chemistry in Texas, confining my inquiries to high schools, and private schools supposed to be somewhat near that rank, up or down. I have had correspondence with the universities also but only with reference to the preparation in chemistry of the students coming to them. I sent out first 125 postals with paid and addressed reply. In these I asked whether or not chemistry is taught in the school and the name of the science teacher. Sixty-two of these were filled out and returned. I must thank the teachers who went to the trouble to comply with my request.

In about half of these schools chemistry was reported. To the science teachers of these and of a large number of other schools where it was supposed that chemistry might be taught, I mailed a circular letter. In this letter I explained, as well as I could, my object, and asked for information on some 30 points connected with the chemical instruction. I sent out about 90 of these letters with stamped envelope and printed blank to be filled out. I have to thank about 40 teachers for filling these out carefully and obligingly. I am under additional obligation to quite a number for personal letters enclosed with the blanks returned. These letters I will answer in time. Prof. A. C. Boylston has kindly put at my disposal information collected by himself in a somewhat similar inquiry. I have complete returns from 36

schools teaching chemistry. These comprise all the large cities and better known schools, in general, so I think I have secured representative returns.

RESULTS OF THE CENSUS

The two text-books most used are Remsen's and Williams'. Williams is used in eleven schools and studied by 261 pupils, Remsen in eight schools, and studied by 92 pupils, while Peters comes next, being used in six schools by 148 pupils. Newell, Hessler and Smith, and Shepard follow in the order named, while a number of other books are used in one school each. In these schools 706 students are studying chemistry in classes ranging from two to 78 students. In practically all the high schools, chemistry is taught in the last year or eleventh grade. In all but four, it is put after physics. Twenty-seven schools report laboratory work as distinct from recitation. Two-thirds report the laboratory as separate from the recitation room. The total value of chemical laboratory fixtures, apparatus, chemicals, etc., is estimated at $21,325.00; and the annual expenditure for chemicals and chemical apparatus at $2,935.00. Two-thirds give exclusive use of a desk or portion of laboratory table to individual students, or groups of students. In twelve schools the students work as individuals, and in the rest mainly in groups of from two to four, while in a few cases the whole class work together on the same experiment in the laboratory. Half assign apparatus to each student, or group, for their exclusive use. The amount of apparatus so assigned varies from $2.00 to $16.00. In sixteen schools the student is held responsible for breakage of apparatus so assigned, the amount of such breakage running from 10 cts. to $5.00 per student, averaging $1.94. In thirteen schools the students pay extra for chemistry. Fourteen give the students a place where apparatus may be locked up. Eight teachers have some assistance in the supervision of the lab-

oratory, preparation of class-room experiments, etc.

The large majority of the teachers seem to have studied chemistry under good advantages, twelve having studied it at the University of Texas, while others have worked at Harvard, Chicago, the University of Virginia, etc. All but four did individual laboratory work in their own study. Nine have had only one year in chemistry. Nearly two-thirds profess some special interest in chemistry and have more or less intention of specializing in it. One man gives his entire time to teaching chemistry, the rest usually a third, or fourth, or fifth, while one man bestows one-twentieth of his working time on his total chemical duties. As to the number and length of the recitation and laboratory periods there is great variation. The shortest laboratory period is 30 minutes and the longest, three hours and ten minutes. In fourteen the laboratory periods are considerably over an hour each, in length.

DISCUSSION OF THE RESULTS—TEXT-BOOKS

The first item is the matter of the text-book. Really the matter of first importance is the choice of a teacher, but the text-book comes first on the list of questions. The very worst book now obtainable is the one most used both as to the number of schools and the number of pupils. One of the saddest single items on the whole list is that Williams' chemistry is used in one of the state normals and sixty-five prospective teachers are being trained in it. Something must be done in this matter. I know that the teacher is not always at liberty to choose the text-book, and I do not wish to blame him where he is not responsible for the selection. However if the man who selects the book knows more about chemistry than the teacher, it would seem wise to let him teach it.

There are reasons why Williams is so popular. It is the easiest book extant to teach. It is as easy as hear-

ing a spelling lesson. No preparation on the part of the teacher, either in the way of previous training in chemistry, or in the matter of looking over the lesson before the class comes into the room, is necessary. The teacher is not required to spend hours preparing elaborate lecture experiments to prove laws or demonstrate theories. The laws and theories are stated and that is all there is to it: they are true because the book says so. The next great beauty (?) of the book is that it (i. e. the book, not chemistry) can be successfully taught without any laboratory, or experiments of any kind. It requires only memory work on the part of the student, and not even that on the part of the teacher. It could be taught just as well on the sun where the temperature is so high that there are no chemical combinations, or even on one of the stars which are composed solely of hydrogen. Williams gives a large number of experiments and many of them are good but they are merely digressions and stand in no essential relation to the matter of the book. The book can be taught without a laboratory, but this book is not chemistry and is only very distantly related to chemistry.

Peters' book has some good points and is far better than Williams, in that it does not teach any particular error, yet it is thoroughly unscientific and gives the student a wrong impression by taking up so much of the theory before any of the facts are reached. Theories are really only explanations of facts, or groups of facts, and an explanation is not needed until something turns up to be explained. Many chemistry books teach the theory as the law and the gospel and only bring in facts subsequently to illustrate the theory.

Remsen's is a hard book to teach. It demands thoughtful preparation on the part of the teacher and requires that the student carry in mind facts for a considerable time until their cumulative effect is felt in its bearing on the theory, when at last the theory is stated. It does not contain pithy categorical statements which may be

memorized by the student, and is for that reason hard to recite on. The book requires good teaching to be taught at all. Several of the other books mentioned are good. I take it that no book can be said to be best in an absolute sense. The teacher should make a very careful study of a large number of texts and decide which one is best for his purpose. And he should know very clearly why he chooses this one or that.

THE DISADVANTAGES OF SMALL CLASSES

In some subjects the fewer there are in the class, the better share do they get of the teacher's attention and for that reason may be supposed to get on faster. This is not the case in chemistry. To make the class hour interesting there must be class-room experiments and thus special preparation on the part of the teacher. Many experiments there are which are necessary to a complete presentation of the subject which are not suited to be performed by the individual student in the laboratory but must be performed by the teacher before the class. Such experiments require considerable extra time and preparation. This is out of the question when the class is small. Even if the teacher should possibly have the necessary time it appears to him not worth while to make elaborate preparation for the class hour when the class is small. In this case also the school authorities will not provide the teacher with the time needed. There is not the inspiration to the teacher, and teachers have to be inspired as well as students. When the class is small the per capita cost of running the laboratory is very largely increased. In most cases an ounce of a chemical costs nearly as much as a pound. I buy a pound of sulphuric acid for less than an ounce can be purchased at retail. Small orders are at much higher rates than larger ones.

PLACE OF CHEMISTRY IN THE HIGH SCHOOL COURSE

The great majority of the schools report chemistry in the last year and put it after physics. This is the correct place for it. Certain chemical experiments can be easily performed and can be made very interesting to children even in the lower grades. Some schools in other states are putting some chemistry even in the graded school. I do not know anything more fascinating than a lot of chemicals, and the wonderful things that can be done with them. The chemical laboratory is the nearest approach on earth to fairyland. I wish that we had more time to do more of a sort of kindergarten work in this direction and thus awaken the interest of children in the wonders of the world about us. O that some Hans Andersen might arise to say the talismanic word and open this enchanted palace of science to the children! Several very good books have been written in which many wonderful things are shown and yet no word spoken of formulae, empyrical or structural, or even of valence, to break the spell. Some of these books really teach considerable chemistry without once mentioning atoms, while some of us think that chemistry is composed of atoms and ions. Some other books tell all that is known, and more too, about atoms and scarcely touch on chemistry.

Some put chemistry before physics as certain chemical experiments are quite easy and can be done by young students. But this is not the kind of chemistry that must be taught in the high school. We must teach it, to a certain extent, at least, as a science and give something of the great generalizations and theories that have done so much for the world. We must teach it in such a way as to get out of it the maximum mental training of which it is capable. Some regard chemistry as merely memory work, or at least, as mainly memory work. This is far from being the case. Chemistry is

argument based on observations, and the observations are entirely of physical properties. We are endowed by nature with five senses and all five of these recognize only physical phenomena. True, the chemist has the taper as his sixth sense, but this, though useful, is not able to supplant the other five. We can not know chemical phenomena directly, but must infer them from observations which are purely physical. A knowledge of physics is necessary as a basis for the study of chemistry. The great majority of the schools reported are right in putting physics before chemistry, and also placing chemistry as near as possible to the end of the high school course.

RELATION OF THE LABORATORY TO THE CLASS ROOM

Conditions may differ somewhat, but, in general, the laboratory work should be distinct from that of the class room. To get good results, neither factor can be neglected. There are still living a few men who think that they can teach chemistry without laboratory work. The younger of these are learning better, the older ones are rapidly dying off. You can buy a book of travel for a few cents, or attend an illustrated lecture on London for a quarter, while a trip to London costs some hundreds of dollars. The results gotten from the lecture and the trip, as regards the amount learned from each, are pretty nearly in proportion to the respective costs of the two. Yet it is comparatively easy to give a person a correct impression of London in a description, since the audience have seen buildings and streets not unlike those described, and hence are in position to build up concepts of the new places from an abundance of familiar material. Chemistry presents a world almost new to the student, and a course in chemistry without laboratory work is comparable to a course of lectures on painting before a man born blind.

To amount to much, the laboratory work must be in-

dividual. When the teacher does the experiment for the class it may do him some good but the class get little from it. When the whole class work together on the same experiment, one or two do the work and get some good out of it. The rest get next to nothing. Two working together sometimes do good work but it is uncertain. One generally learns something but even his attention is considerably divided. Individual, independent work is the only kind that amounts to much.

Some have gone to the other extreme and thought that the class room work could be eliminated. A great deal of instruction must be done in the laboratory. The attention of a student can be best called to a phenomenon while he has the experiment in hand. A teacher can not be furnished to each student to sit beside him and explain everything to him as it is observed. To explain all of the laws, theories, etc., to each student, individually, takes too much time and attention on the part of the teacher. Some have avoided this by getting up before the class in the laboratory, lining the students up and having them go through with an experiment in concert. In some cases this may degenerate into the kind of work done in a certain northern high school. Orders are said to have been given about as follows: "Company attention! Present test tube! Pour! Observe black precipitate!"

In the laboratory the student should be given time to think, think for himself, and time to observe, observe for himself. He should be given time to solve his own difficulties, if possible, either by his own reasoning or by reference to some book. When help is given him, it should come in the way of guidance, rather than of lifting him up and carrying him. The fact that the student does the looking and thinking for himself is the main thing, and the independence of the observing and thinking is not to be sacrificed to the desire to increase the space covered. Considerable time is necessary in the class-room for the teacher to sum up the evidence, present the conclusions, discuss the laws of the science,

describe the applications to the arts, etc. The teaching in the class-room and in the laboratory should go on side by side. As a general rule twice as much time should be spent in the laboratory as in the class-room.

PRESENT VALUE OF CHEMICAL EQUIPMENT

The total value of chemical laboratory fixtures, apparatus, etc., is put at $21,325.00. This is the sum of the estimates given. Estimates vary considerably according to what one includes in the estimate, and also according to the magnifying power of one's glasses. This figures out to be $32.00 per pupil taught. In the various schools, it runs from $138.00 per pupil down to "?". The average given is reasonably good and is more than I should have expected. In some cases the estimate is rather liberal, and in others the amount has not been expended to good advantage. The efficiency of a given amount may be large or small according to the experience and judgment of the man who expends it.

AN ESTIMATE FOR A CLASS OF TWENTY

The first item is suitable laboratory desks or work-tables. I think that I am in a position to speak on this matter as I have visited a large number of the largest universities in the United States and Canada as well as many lesser institutions. I inspected many of these with special reference to the equipment of my own laboratories at Baylor. All of the fixtures in the Carroll Chemical Laboratory at Baylor were built to my drawings. We will suppose that the class of twenty work in two sections of ten each. Each student while working, must have three feet of space. This will require thirty feet of desk for the class. Each space of three feet may have two lockers and drawers under it so that each of the two students using it has a separate place to keep his apparatus. The top may be of oak simply oiled with linseed oil; the rest of pine stained and varnished. Each

of the lockers beneath has its own key. Desks of this order can be made of good material complete and finished for $5.00 per running foot. This does not include plumbing. Some saving might be made on this by making them a little plainer. Thus we have ten desks which may be used by twenty students, working in two sections, at a cost of $150.00. A hood for experiments requiring the use of disagreeable chemicals, etc., must be provided. This will cost some $25.00. Shelving, etc., will cost about $25.00 more. The plumbing can be put in for $100.00. This gives two sinks to the room, and a connection for a rubber tube for water, and two connections for gas to each working space of three feet, and water and gas connections for hood. Less plumbing than this would do, and less would be required in places not using gas. In some cases the plumbing would then amount to not more than $25.00. Thus the fittings for the laboratory can be put in for $300.00, or less. The laboratory should be separate from the classroom, and, if possible, should be about 15x20 feet. Somewhat less space will do.

A small room or closet near by must be provided, fitted with plain but suitable shelves for storing apparatus and chemicals. As, however, each locker is kept supplied with a full set of apparatus which is put in before the session opens, a large part of the apparatus in hand is constantly in the laboratory desks, and the store-room need not be as large as at first sight might seem to be required. The shelving in this room may cost $25.00.

A stock of chemicals which would need replenishing only after some considerable time can be put in for $50.00, though it would be greater economy to purchase some things in larger quantity. In the matter of buying chemicals great mistakes are made by inexperienced teachers. I remember that in a certain laboratory, which I visited, the supply of sulphuric acid consisted in a one pound bottle of guaranteed chemically pure, redistilled, sulphuric acid. That grade of acid is rarely

used in even the most advanced analytical work. The cheapest grade of commercial chemicals is all that is required in the majority of the experiments for beginners. The saving of cost by using a cheaper grade of chemicals is very considerable. Some capital is required to buy to advantage, as a great saving can be made on a comparatively large bill bought at one time. However, the teacher must do the best he can on this, as in other matters, and use the amount avaliable to the very best advantage. Yet the money is usually forthcoming when the need of it is shown and the ability of the teacher to use it is also demonstrated.

On apparatus, more than on chemicals, a large saving can be made by buying a large quantity at one time. It then becomes possible to import duty-free, which saves something like one-third of the cost, besides the advantages obtained on account of the size of the order. A fair stock of apparatus for a class of twenty students can be purchased for $200.00, though $250.00 would be better. Then for the laboratory and its equipment for a class of twenty about $675.00 would be needed, but $500.00 could be made to serve. This comes to $33.00 or $25.00 per student. This requires a fair outlay at one time, but, if things are properly managed, the additional yearly expense will not be so very great. Five or six hundred dollars for a school of the size and rank contemplated is not too much to put into a chemical equipment. If chemistry is taught well it is worth that much; if it is not taught right it is worth little or nothing and something which can be taught well had better be put in its place.

LABORATORY FEE FOR CHEMISTRY STUDENTS

In eleven schools the students pay extra for taking chemistry. This is a solution of the problem of current supplies in the way of chemicals, gas, water, etc. With proper buying, a five dollar fee from each student in the course, will cover the cost of all material used up by the

student in a thoroughly good beginner's course, such as should be taught in the high school, and leave a margin for some little improvement each year. My experience in seven years of teaching chemistry has shown me that students do not mind paying a laboratory fee of reasonable size provided they see that they are getting something for it. In business, as a rule, it is far easier to dispose of a thoroughly good article whose merits can be seen, at a good price, than it is to get rid of a worthless article at a low figure. Then if you want to have laboratory work, have it right and charge the students up with the cost and they will pay it cheerfully and be pleased with the bargain. The average annual expenditure reported is about $4.35 per student. The amount varies considerably, being reported all the way from $55.00 per student down to 14 cents, while some keep a discreet silence on this important point. We naturally envy the man who has $55.00 per student to spend each year. The 14 cent expenditure is from one of the largest cities in the state. This seems rather small. We will hope that the students in this school learn an amount of chemistry out of all proportion to the amount of chemicals and apparatus they destroy. Six or seven dollars per student, a year, if well spent, will keep up the stock of apparatus and chemicals.

HOLDING STUDENTS RESPONSIBLE FOR BREAKAGE

Nearly half the schools hold the student responsible for breakage and damage of apparatus. The amount reported so paid runs from 10 cents to $5.00 per student, averaging $1.94. A teacher in one of the largest cities writes: "Hardly ever is anything broken in chemical work here." Some boys wear out very few shoes in summer but that is not entirely due to their extreme carefulness of their footwear. Now, the normal youth can break more than ten cents worth of apparatus a year. If he does not surpass that figure he is either abnormal or he does not come into very intimate contact

with glassware. Careful checking up and charging for broken apparatus is largely the solution of the apparatus problem. I find that students do not mind paying for the apparatus they break. I give them good apparatus and plenty of it—and hold them strictly responsible for every bit of it. The bill for the individual student is not unreasonably large and he pays it cheerfully. I charge him enough to replace the apparatus, freight paid. I keep the bills down, so far as possible, by buying under the very best advantages. If this method is properly followed from year to year, the supply of apparatus should remain practically as good as new. Chemical apparatus lends itself particularly well to this sort of dealing.

In physics, for instance, each experiment requires, as a rule, apparatus quite different from that used in other experiments, so that each student employs, at different times in his course, apparatus running well up into the hundreds of dollars in value, and it is impracticable to assign each student a set of apparatus for any number of experiments. The physics teacher has a hard problem in assessing damage and keeping up his stock, but for the chemistry teacher, it is a comparatively simple matter. A nearly complete set of apparatus for the entire list of experiments in any reasonable laboratory manual, can be given each student at the beginning of the term and checked up at the end, and the damage made good. An additional advantage in chemistry is in this: It is difficult to assess damage on the kinds of aparatus used in some other sciences, but that used in chemistry lends itself particularly well to such treatment. For instance, a flask is given the student at the beginning of the term. At the end of the term, if it is not broken, it is just as good as new, and if it is broken, it *is* broken and is to be paid for. There are no questions to come up for delicate judgment and nice discrimination. A few things such as iron stands, Bunsen burners, etc., deteriorate from year to year but if these

are regularly painted and some allowance made for them in assessing the annual laboratory fee, the loss is not great.

ASSIGNING APPARATUS TO EACH STUDENT

Holding the student responsible for breakage involves assigning a specified amount of apparatus to each student for his exclusive use. Apparatus is reported so assigned in half of the schools. The amounts run from $2.00 to $16.00. In one school the amount assigned to each student, multiplied by the number of students in the course, considerably exceeds the amount of apparatus put down as possessed by the school. This teacher should either get more apparatus or not be so liberal with his students. According to the manual used, and the length of the course, from three to eight dollars of apparatus should be given each student. There is far less loss to the school when a hundred dollars of apparatus is broken and paid for, than when ten dollars worth is broken and not paid for.

In the case of the more costly pieces of apparatus, such as burettes, electrolytic apparatus, etc., two or three sets can be bought for the whole class and lent to each student for the time he is actually using them. These are required by the student only once or twice during the session and it is not hard to keep record of them.

A PLACE FOR EACH STUDENT TO KEEP APPARATUS

If the student is to be held responsible for apparatus, it is essential that a secure place be given him in which to keep it. He should have the key to this place and have exclusive use of it. The estimate given above for the laboratory desks provides a drawer and locker, each about 16 inches wide for each student. The locker has a shelf to increase its capacity, this shelf being cut out in front so that the whole height of the locker is availa-

ble for the storage of iron stands or other tall apparatus. Twelve schools give the student a place for storage of apparatus.

ASSISTANCE FOR THE TEACHER

Eight teachers report some assistance in matters of detail, such as care of apparatus, etc. This is to be commended. A teacher can accomplish much more by having such assistance. There are frequently some more advanced students who can give some little time to this sort of thing and can render really valuable aid. The remuneration may be very small, in money, but the experience may be worth much to them. It is greatly to the interest of the school to furnish the teacher with all the assistance he can use.

SOME CONCLUSIONS AS TO THE LABORATORY

We may conclude, then, that a really good chemical laboratory is not so expensive as might be supposed, and can be procured and maintained without an unreasonable expenditure. This is within reach of every high school which really is one. The laboratory sketched above is for the high school. It is none too good, and less is not good enough. The "colleges" can not afford to aim for less than the high school. I put the word in quotation marks as that is what they call themselves. I will leave the responsibility of the designation with them. I have written to many of them but gotten few replies. Still I know them pretty well as I have visited some of them and had students from others. I know that some of them are honestly trying to do good work and have hard-working teachers in them. I have the very kindest feeling for these teachers and give them my best wishes; my only desire is to aid them. But somehow I do wish that the names and pretensions of some schools, and their actual equipment and work could meet each

other half way. School catalogues should no longer be classed as imaginative literature. Metonomy is all right in poetry, as a figure of speech, but when a beaker or two and a few test tubes are put for a "well-equipped" laboratory it comes alarmingly near breaking one of the commandments; that is, provided the man knows what a laboratory is. I express myself mildly. We are under no special obligations to teach chemistry, but if we do teach it at all we are under obligations to provide reasonable facilities for doing it well.

THE PREPARATION OF TEACHERS

The great majority of the teachers report having studied chemistry two years or more. A number have studied it only one year. One year's study is insufficient preparation for teaching it. The preparation of the teachers seems to be rather better than was to have been expected. The ideas of various people as to what constitutes an adequate preparation for teaching chemistry vary considerably. Several summers ago, in Baltimore, a young man came to me with a copy of Williams' chemistry in his hand, saying that he had never studied chemistry at all, but wanted five hours tutoring in it, as he was to teach chemistry the next session in a New Jersey high school. The deficiency in the preparation of the teachers, so far as a deficiency exists, is, in part, to be remedied by the school management. Thorough preparation should be demanded of the teacher. The demands on the teacher are now in most cases large for the compensation offered. The schools must have well prepared teachers even if they have to pay for them. Improvement in this way will come only through growth and will be rather slow.

There is a quicker remedy in the hands of the teachers. That is for them to turn in and get prepared. None of us are too well fitted for our work. We, more clearly than any one else, see the weakness and insuf-

ficiency of our preparation. It is with us to remedy it. Some are teaching only to fill in the time, or to make sufficient money to enable them to go on with their preparation for law, or medicine, or some other profession. I have no message for them except to express the hope that they may make the money as soon as possible and get on into the successful practice of their chosen professions. The rest of us who are in teaching to stay can do something and must get about it. We must fit ourselves for good teaching, and must do that sort whether we get paid for it or not. A salary is as desirable to a teacher as to any one, but after all, it is not the main consideration. Being a poor teacher is far worse than getting a poor teacher's pay. I can look with complacency on the prospect of always getting a small man's salary but I do worry considerably over the thought of forever remaining a small man.

The summer school is, for many, the solution of this problem. I am glad to meet, each summer, a great many Texas teachers at Chicago. There were some two hundred there last summer. I wish that all the rest would go too. I am very glad that Mr. Rockefeller has built that school for us. I am glad that he located it up there where the weather is cool in the summer. Harvard, Yale, and Columbia, also, offer many attractive things in their summer schools. These are open for six weeks and offer, with good facilities, anything that is commonly included in a two years' college course in chemistry. At Chicago, the University, as such, is open for the summer quarter of eleven full weeks and offers in the summer every sort of work just as in the winter. Some of the teachers might find something yet to learn even within Texas.

LONGER PERIODS FOR LABORATORY WORK DESIRABLE

In some schools the laboratory period is only thirty minutes. It requires some time for the student to get

his desk open and apparatus out; then he has to put on his apron and ascertain what he is to do. By the time he gets to work, ten minutes or so has gone by. He has to quit a few minutes before the bell rings to get his things put away and himself in shape to go to a class. If the period be a short one, a considerable fraction of it is thus spent in beginning and quitting. Many experiments require an hour or more of continuous work, and if the bell rings in the middle of this time, the experiment is ruined and time spent on it lost. Two hours is as short a laboratory period as can be put to good advantage.

EXTRA TIME ALLOWANCE FOR CHEMISTRY TEACHERS

A reform must come in the matter of the time allowed for a chemistry teacher's work. In high school teaching, formal lectures are not required, and, in fact, lectures are not suited to the instruction of pupils of that age. Some experiments are too elaborate to be performed by each student, other experiments must be before the class when certain conceptions or theories are presented. The teacher must prepare these beforehand and perform them before the class. Unless the teacher make some specific preparation for each class hour, the class hour will be a dull one. If the teaching of chemistry is to be different from that of Latin, or history, the chemistry man must have the time to make it different. The most of the teachers put only one-fourth, or less, of their working time on their whole chemistry work, while some go as low as one-twentieth. In order to do their chemistry work well, a number of the teachers work after school, at night, and some even on Sundays! The school board has no right to require this of them, but still the man who is worth anything is going to teach chemistry to the best of his ability whether he gets pay for extra work or not. The pay is an incident, a very agreeable incident, I admit, but still an incident.

This year, for the first time in Texas history, one

high school employs a man for his whole time to teach chemistry. The variety of the subjects other than chemistry, taught by many of the teachers is remarkable. One man in a "college" carries, in addition to his college course in chemistry, physics, physiology, physical geography, geography, Texas history, and three Latin classes. He failed to state the number of courses taught in any except the Latin. Another man teaches five other sciences; while another's branches are "too numerous to mention." Still another teaches algebra, geometry, history, and Latin. Several others carry as many as six branches in addition to their chemistry.

A SATISFIED TEACHER

One teacher maintains that laboratories are luxuries and are quite out of the reach of any ordinary institution, besides being unnecessary for the thorough teaching of chemistry. He seems to be happy and satisfied with his work and equipment, though the latter might be carried off in a wheelbarrow. His school is called a "college" and gives all the known degrees, and some unknown ones.

CHEMISTRY IN HIGH SCHOOL AND COLLEGE

I can not here give this topic the discussion which it manifestly deserves. It is a hard question, and, so far as I know, has not been satisfactorily solved. Such a large proportion of college students have not had chemistry that the college course has to begin at the beginning. The college students are older and can work much faster so that a month of college work covers much more ground than the same amount in the high school. As the presentation of the subject is to more mature pupils, and as the facilities of the college should be so much better, there must be a great difference in the manner, as well as in the amount of the teaching. If the chemis-

try course in the high school and in the university are equivalent, then either the high school man or the university teacher is making a sad failure in his teaching. I have had correspondence with all the universities in Texas on the question of college credit for high school chemistry. No very definite understanding has yet been reached.

Nine-tenths of the students in the high school are not coming to college. These should have a course in chemistry for the training there is in it, and also for the information and knowledge about the world about them, which can be thus gotten. Personally, I wish that those who are coming to college would not study chemistry at all in the high school but spend the time on Latin, mathematics, and physics. For a proper college course in chemistry, the training derived from good work in the above three lines is a far better preparation, than even a fairly good high school course in chemistry.

Co-operation and mutual help is needed to bring the science teachers of the state into a better position with regard to this and to other problems. If the work done in the high schools is made more uniform it will be easy to obtain recognition of it on the part of the colleges. One teacher proposes an association of science teachers. That might produce good results.

A WORD AS TO THE FUTURE

There is hope for chemistry in Texas. There is going to be more demand for chemistry teaching, and with that a demand for men trained to teach it well. In this correspondence two superintendents have asked me for the names of men able to teach chemistry. Quite a large number of schools are planning to improve their laboratory facilities. Only one or two seem satisfied with what they are now doing. Chemistry is coming to take a more important place in all branches of industry, and with this will come an enlargement of its place in

the schools. In the movement toward the diversification of crops, that is now upon us, the cultivation of chemistry must have a part. Membership in the American Chemical Society may be taken as an index of the interest in chemistry in the various sections of the country. Membership in this organization is open to all on equal terms. Rhode Island has 33 members while Texas has 10. We are just barely beginning to get interested in chemistry in Texas.

A PARTING WORD

I did not undertake this task in time to get as complete information as I could have wished. I have not meant to reflect on any teacher or any school. I have spoken strongly because I feel strongly. I believe in real work.

I have enjoyed the correspondence. I have been glad to exchange letters with many whom I have met and am glad, even in this imperfect way, to make the acquaintance of many others. I hope to keep in touch with as many of these as possible. I have very much to learn from others. On the other hand I shall be glad to assist any of my fellow teachers in any way that I may, even to the extent of lending desk-plans or making out orders for apparatus and chemicals, or in any other way. I shall be pleased to hear further from any of them on subjects chemical or personal. This is neither the beginning nor the end of my interest in chemistry teaching. My most immediate advice to chemistry teachers is to read and digest Smith and Hall's "The Teaching of Chemistry and Physics" (price $1.50, Longmans, Green, and Co., New York.) It is the most inspiring thing I have seen on the subject. Read it whether you read this or not.

With hearty good will to all interested in the teaching of chemistry in Texas, I close these few remarks.

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Books must follow sciences, and not sciences books.

—Bacon.